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# CRYSTALLOGRAPHY AND TECHNOLOGY

by L. Belyayev

- USSR -



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[Following is the translation of an article by L. Belyayev, Deputy Director, Institute of Crystallography, Academy of Sciences USSR, in the Russian-language newspaper Vechernyaya Moskva (Moscow Evening), Moscow, 19 January 1963, page 2.]

Crystallography and technological progress .... It is not very long ago that such a comparison would have appeared strange. Yet there was a time when crystallography was considered only as an introduction to mineralogy. The science of crystals, impetuously expanding, came into a close relationship with technology. It was found that the creation of materials necessary for the production of new modern devices and machines is impossible without a deep knowledge of the nature of a solid, its atomic-crystalline structure and the processes of growing crystals.

The remarkable properties of crystals distinguish their value for the development of radioengineering, electronics, and semiconductor technology.

For instance, owing to their electronic properties, many crystals are used as unusual radiation transformers and converters of energy from one type to another. They make it possible to convert the energy of oscillation into electrical energy. Just such crystal converters are employed in hydroacoustic receivers, microphones, and various transmitters. At the same time, electrical oscillations may be converted into mechanical oscillations using a crystalline piezoelectric emitter.

Crystals also have the capacity to produce many other extraordinary transformations: thanks to pyro-electric crystals temperature variations are obtained by electrical signals.

It was found that it is possible to convert one length of electromagnetic wave to another simply and easily, using crystals. A particularly important property of crystals is not only to transform one type

of energy into another, but also to generate and amplify short and ultrashort waves. That very property permitted their application as microwave and light wave quantum generators. And this lead to a real revolution in technology.

It is not difficult to foresee that there will not only be further development in ultrashort wave radioengineering and the automatisation of production, but also increases in the speed of electronic computers which will require the replacement of vacuum electronic devices by crystal devices. In many cases they exceed previous reliability, and are lighter and smaller in size.

Studying the laws of the structure of matter, Soviet crystallographers persistently seek means of further practical application of the results of these works.

One basic direction in the works of our institute is the growing of artificial crystals, which are badly needed in instrument making and other areas of production. This is a complex business entailing the construction

and preparation of crystallization devices, the selection of the necessary crucibles for these same purposes, the selection of chemicals and, of course, the investigation of these very processes of growing crystals.

Soviet scientists already have given industry the methods for preparing many crystalline materials, such as artificial rubies, which are used in quantum generators. This year in our institute, the development of a new, improved method of growing rubies was accomplished.

Jointly with the manufacturers the production of iodine lithium crystals with previously fixed isotope composition was mastered. They are used for the preparation of highly sensitive counters to record neutrons.

The method of growing the so-called optical crystals has been refined, for example, fluorite was added successfully. A new type of electrical furnace was created in our institute for this purpose. Tests showed that with it it is possible to obtain a very

high vacuum (that is, a rarefied atmosphere) with a high temperature, which is particularly important for the preparation of high quality crystals. The design of the new furnace was provided to industry.

The value of crystalline semi-conductor materials for new techniques is widely known now. An important role is played by silicon, germanium, and other semiconductors and their alloys in many electronic devices. However, the reliability of semi-conductor components is not always the same -- sometimes irregularities in the structure of the crystal, so-called internal strains and dislocations, may reduce the reliability of these devices. By failing, any miniature semi-conductor triode may halt the operation of a complex radio engineering device.

Methods for checking the structure of the semi-conductor crystals were developed in the institute. An apparatus based on these methods was also built which 'sees' and fixes even the slightest irregularities in a homogeneous crystal.

One recently completed operation is even being discontinued. It is of interest to the construction industry. In short, a detailed study of the regularity of the crystalline structure of cement-producing silicants successfully lead to changes in the recipe for the preparation of cements. New materials introducible in their components improve the quality and increase the durability. At the same time the preparation of the cement is reduced. With the concern of the institute in aiding the workers of industry a pamphlet was issued, in which the new method for the preparation of cement was described.

In conclusion I want to emphasize the significance of rapid and operational transmission of the scientific operations of industry.

**The November Plenum of the Central Committee of the CPSU obligated the scientific workers to participate actively in the solution of the large problems of technological progress.**

However, we know from experience how often scientific work loses practical value if it remains a long time within the walls of the laboratory. Therefore, not waiting when the industrial worker turns to them for help, the institute takes the apparatus created and the methods into the factory and the department and continues their investigation under factory conditions. Scientific collaborators, researchers, and mechanics constantly go out to enterprises. Together with the factory workers they adjust new apparatuses, train cadres, and help familiarise them with the production processes. This cooperation is usually accomplished by the production of an experimental batch of the product. The manufacturing technology for their production is established and perfected here in the enterprises.

Occasionally we invite workers interested in production to the institute and to the laboratories to master new research methods. Together with us they take part in the creation of types of new materials and manufacturing models. Then we jointly develop, theorize and

publish the results achieved in the form of special collections.

All this creates a prolonged union of science and technology and helps actualize the results of scientific efforts quickly and accurately.

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